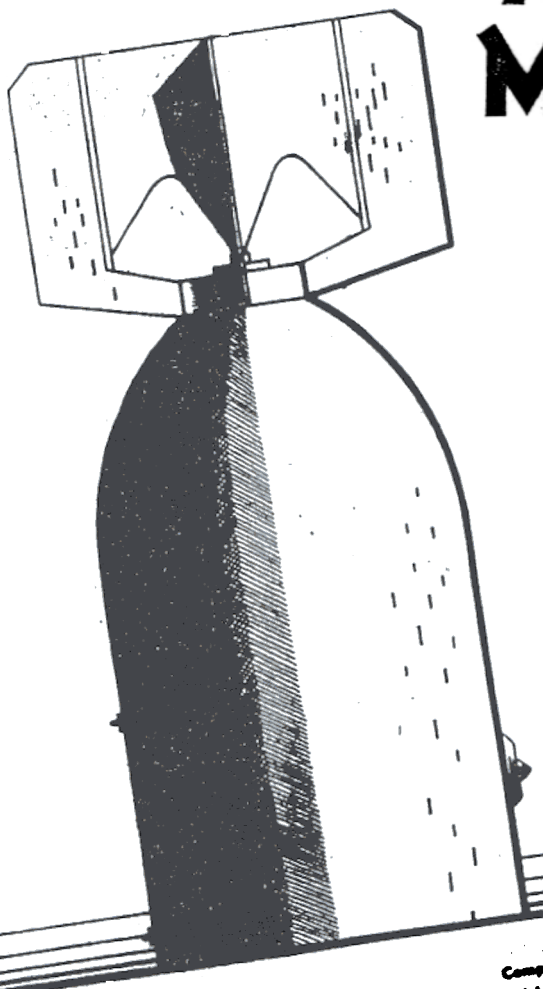
AIRCRAFT MUNITIONS

Versus

SPECIFIC TARGETS

VOLUME I
MUNITIONS



Compiled by
NAVAL AIR MOBILE TRAINER (MUNITIONS) NO. 6
BOMB AND FUZE SCHOOL, BLDG. 293
U. S. NAVAL AIR STATION
SAN DIEGO 36, CALIFORNIA

by direction
COMMANDER, FLEET AIR WEST COAST

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14 May 1945

AIRCRAFT MUNITIONS VS. SPECIFIC TARGETS

VOL. I MUNITIONS

1. These booklets, Vol. I and Vol. II, were written and compiled for use in conjunction with a course in the "Tactical Selection of Bombs and Fuzes," established by Commander, Fleet Air, West Coast in Training Memorandum 49-44.

2. This publication is CONFIDENTIAL and should be safeguarded and handled in accordance with the current edition of Registered Publication Manual and Article 76, U. S. Navy Regulations, 1920.

J. B. MURRAY, Lt. (jg), USNR
OinC

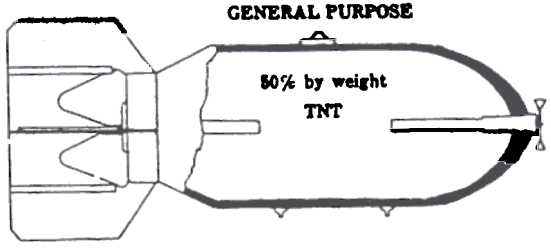
/s/ L. E. Klein
By direction.

INDEX

GENERAL PURPOSE

Tail Fuzes		Delays
AN-M100A2 series		Non-delay*, .01†, .025†, 0.1†, .24††.
M115	"	4-5, 8-15 sec. (no nose fuze)
M123A1	"	1-144 hours "
Mk 237-238		2, 10, 30 hours "
M132 series		10 minutes "
AN-Mk 230††		(Hydrostatic for 500, 1000, 2000 Lb.)

Key: Symbols indicate fuzing combinations.
NB: .24 sec. delay preferable with Mk 243.
Non-delay tail with .1 sec. nose may be used.

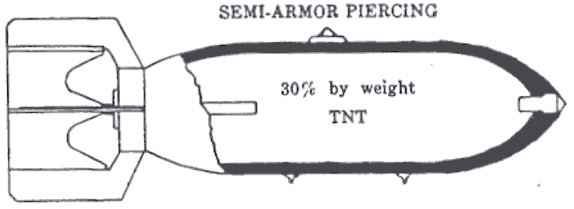


Nose Fuze

AN-M103A1—Inst.* or .1† by setting pin
M 139A1—Inst.* or .01* by setting pin
M 140A1—Inst.* or .025† by setting pin
AN-Mk 219—Inst.*
Mk 239—0.01*
Mk 243††—.025 dud; water discriminating
VT Aerial Burst Fuzes—T91* and T92*

SEMI-ARMOR PIERCING

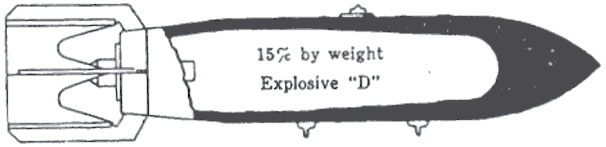
Tail Fuzes	Delays
Same as above with omission of AN-Mk 230	



No nose fuze used

ARMOR PIERCING

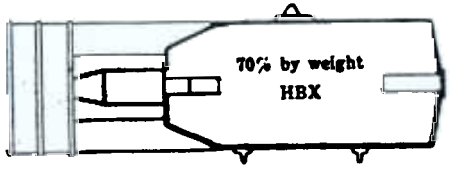
Tail Fuze	Delays
AN-Mk 228	.08 sec.



No nose fuze used

DEPTH BOMB

Tail Fuze	Delays
AN-Mk 230	Hydrostatic settings 25-125 feet



Nose Fuze

AN-M103A1 Inst. only
AN-Mk 219 Inst. only

NB: Use of nose and tail fuze combination not authorized.

AIR TRAVEL TABLE

Fuzes	Tail or Nose	Maximum Air Arming Travel (Ft.)	Vertical Fall in Feet When Released from Horizontal Flight at				Remarks
			100 Knots	150 Knots	200 Knots	250 Knots	
Mk 219 and AN-Mk 219	N	1100	520	300	165	105	2000-2500′ Max. Air Travel to Arm in Flat Nose Depth Bomb.
Mk 221	N	1100	520	300	165	105	400 ft./sec. Striking velocity needed to function on water impact.
Mk 223	T	1100	520	300	165	105	400 ft./sec. Striking velocity needed to function on water impact.
AN Mk 224 and Mk 224		None					Athwartship—Hydrostatic. Arms by Hydrostatic pressure.
Mk 227	N	1500′—Near Sea Level 3000′—At 20,000′ Altitude					Arms by Centrifugal Force Resulting from Spinning of Bomb in Flight.
Mk 228 and An-Mk 228	T	1100	520	300	165	105	
Mk 229	T	500	130	60	35	20	
Mk 230 and An-Mk 230	T	400	95	52	31	20	
Mk 234 and AN-Mk 234		None					Athwartship—Hydrostatic—Arms by Hydrostatic Pressure.
Mk 243	N	500	130	60	35	20	
M-103	N	3000	2145	1600	1120	800	
AN-M103 (delay)	N	1080	580	335	200	135	2500′ Max. Air Travel to Arm in 325-350-Lb. Flat Nose Depth Bomb, may not arm is used in 650-700-Lb. flat nose depth bomb. If special depth bomb vane is used, 1500′ max. air travel will arm fuze when installed in largest depth bomb.
AN-M103 (inst)	N	1620	1060	690	440	290	
AN-M100A2	T	485	145	65	40	25	
AN-M101A2	T	555	190	90	55	20	
AN-M102A2	T	665	265	130	80	45	465′ Air Travel to Arm when installed in 1000-Lb. GP.
M-110 and AN-M110A1	T	725	260	125	75	40	
M112, M113, M114	T	100	8	4	6	2	4-5 and 8-15 second delay, not safe for carrier use.
M115	T	485	145	65	40	25	M115, M116, M117. Fuzes have 4-5 and 8-15 second delay.
M116	T	555	190	90	55	30	
M117	T	665	265	130	80	45	465′ Air Travel to arm when installed 1000-Lb. GP.
M123	T	370	80	40	28	20	Long delay fuzes 1 to 144 hours, require an additional 500′ to 1000′ to seal fuze body to prevent leakage of fluid after fuze is armed.
M124	T	370	80	40	28	20	
M125	T	370	80	40	28	20	
AN-M126 and AN-M126A1	N	725	260	125	75	40	

NOTE:
The arming distances shown are the maximum arming distances for the fuzes when installed in the largest bombs in which they are normally used. The arming distances will be somewhat less when fuzes are installed in smaller bombs.

BOMB: GENERAL PURPOSE, 100-LB., AN-M30A1

Overall Length	38.46"
Body Diameter	8.18"
Fin Width	11.0"
Total Weight	115.0 lbs.
Explosive Weight (TNT)	57.0 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	2	TBM-5	12	PBJ-1J	12
F7F	2	FM-2	2	SB2C-5	6	~~PB4Y-2~~ PV-2	8

(Multiple suspension possible)

PBM-5 12
PB4Y-2 20

FUZING DELAYS:
144, 72, 48, 36, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.24, 0.1, 0.025, 0.01 seconds; non-delay instantaneous; 20-80 foot air burst.

BLAST:
430 psi pressure at 8 feet.
Radius—50% probability of casualty (instantaneous fuzing):
Man in foxhole 8', man lying on ground 20', man standing 40'.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT.
(Ballistc Coefficient—1.2)

Altitude	Horizontal Bombing				40 Deg. Dive				60 Deg. Dive				90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		200 knots		400 knots		200 knots	400 knots
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	390	37	628	20	401	52	688	44	402	66	696	62	405	700
1,500	410	44	636	25	429	56	695	47	431	69	706	63	434	711
2,000	440	48	644	29	459	59	702	48	461	70	716	64	463	722
2,500	460	51	652	33	482	62	710	50	486	72	725	65	488	732
3,000	490	54	668	34	507	64	718	51	511	73	734	66	514	742
5,000	560	62	685	45	588	69	745	56	593	76	766	69	596	776
7,000	630	65	720	49	662	72	777	60	656	77	797	71	660	807
9,000	690	70	750	52	704	74	805	62	709	80	825	72	713	834
15,000	810	75	825	65										
20,000	860	78	875	69										
30,000	910	82	910	75										
35,000	920	83	920	77										

BOMB: GENERAL PURPOSE, 250-LB. AN-M57A1

Overall Length	47.8"
Body Diameter	10.93"
Fin Width	14.9"
Total Weight	260.0 lbs.
Explosive Weight (TNT)	129.0 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	2	TBM-5	4 (if bombs are staggered)	PBJ-1J	8	PBM-5	8
F7F	2	FM-2	2	SB2C-5	4	PV-2	8	PB4Y-2	12

FUZING DELAYS:

144, 72, 48, 36, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.24, 0.1, 0.025, 0.01 seconds; non-delay instantaneous; 20-80-foot air burst.

BLAST: 430 psi at 11 feet.

Radius—50% probability of casualty (instantaneous fuzing):
Man in foxhole 11 feet, man lying on ground , man standing

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT.
(Ballistic Coefficient—1.7)

Altitude	Horizontal Bombing				40 Deg. Dive				60 Deg. Dive				90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		200 knots		400 knots		200 knots	400 knots
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	400	35	630	20	406	51	698	44	407	66	703	62	410	707
1,500	425	44	650	25	436	56	709	47	438	69	716	63	441	721
2,000	450	46	670	29	467	59	720	48	470	70	730	64	472	735
2,500	475	50	680	32	493	62	731	50	496	72	742	65	499	747
3,000	500	53	690	34	519	63	742	51	523	73	754	66	526	760
5,000	600	62	730	43	608	68	785	56	611	76	798	68	614	805
7,000	665	64	770	46	679	71	823	59	682	78	838	70	687	846
9,000	730	68	810	51	739	74	859	62	742	79	875	72	746	884
15,000	860	75	905	63										
20,000	925	77	945	68										
30,000	985	81	985	73										
35,000	990	82	990	76										

FRAGMENTATION: (Initial Fragment Velocity—7,320 ft./sec.)

Density (sq. ft./fragment)	Pattern Areas (sq. ft.) Concentrics	Mild Steel 1/8"	Mild Steel 1/4"
1 sq. ft./frargment			
4 sq. ft./fragment			
10 sq. ft./fragment			
Max. Frag. Distance (.01 fragment per 100 sq. ft.)			

CRATERING: Depth (feet) x Diameter (feet).

Fusing	0.1 Sec.	0.025 Sec.	0.01 Sec.	Instantaneous
Clay	7x26	7x26	8x26	2x5
Hard Chalk or Coral	6x19	5x19	6x20	1x4
Sand	6x20	5x19	6x20	1x7

MINING: Distance from bomb explosion for damage to pipe: Ceramic, 29 feet; cast iron, 17 feet.
Thickness of reinforced concrete wall breached by 2 feet near miss: 4.8 feet.

PERFORMANCE AGAINST CONCRETE (5,000 psi)
Perforation—1' maximum if dropped above 5,000 feet.
Deformation of bomb against massive concrete—800 feet.
Rupture of bomb against massive concrete—7,000 feet.

PENETRATION OF CLASS "B" ARMOR PLATE: 1.0" maximum at approximately 500 ft./sec.

MINIMUM SAFE RELEASE ALTITUDES: (Short Delay Fuzing; horizontal flight after release).
Combat — 500 ft. (1% Theoretical Fragmentation Risk)

Training—1,500 ft. (0.3% Theoretical Fragmentation Risk which after extensive Army tests proved justified).
3,000 ft. (Theoretical Fragmentation risk negligible).

BOMB: GENERAL PURPOSE, 500-LB., AN-M64A1

Overall Length	59.16"
Body Diameter	14.18"
Fin Width	18.94"
Total Weight	525.0 lbs.
Explosive Weight (TNT)	267 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	2	TBM-5	4	PBJ-1J	6	PBM-5	8
F7F	2	FM-2	0	SB2C-5	2	PV-2	6	PB4Y-2	12

FUZING DELAYS:
144, 72, 48, 36, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.24, 0.1, 0.025, 0.01 seconds; non-delay instantaneous; 20-80 foot air burst; hydrostatic (25'-125').

BLAST: 430 psi at 14 feet.
Radius—50% probability of vasualty (instantaneous fuzing):
Man in foxhole 14', man lying on ground 40', man standing 75'.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT.
(Ballistic Coefficient—2.5)

	Horizontal Bombing				60 Deg. Dive				60 Deg. Dive				90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		200 knots		400 knots		200 knots 400 knots	
Altitude	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	415	37	675	20	411	51	705	44	412	66	708	62	414	712
1,500	455	43	690	27	443	56	719	47	444	69	724	63	446	728
2,000	460	47	700	29	475	59	734	48	477	70	741	64	479	744
2,500	480	50	715	32	502	62	748	50	504	72	755	64.5	507	759
3,000	510	53	730	35	530	63	762	51	532	73	770	65	535	774
5,000	610	61	770	42	624	68	815	55	626	76	824	68	629	829
7,000	685	65	820	47	701	71	862	59	704	78	873	70	708	878
9,000	755	68	855	52	767	73	906	61	770	79	918	72	773	924
15,000	905	73	960	60										
20,000	975	76	1005	64										
30,000	1050	79	1050	70										
35,000	1060	80	1060	72										

FRAGMENTATION: (Initial Fragment Velocity—7,390 ft./sec.)

Density (sq. ft./fragment)	Pattern Areas (sq. ft.) Concrete	3/8" Steel	1/4" Steel	1/8"
1 sq. ft./fragment	8,600	7,220	4,500	3,000
4 sq. ft./fragment	26,100	21,150	11,400	11,150
10 sq.ft./fragment	49,750	37,500	20,600	20,000

Max. Frag. Distance 1,000 ft. 600 ft. 500 ft. 200 ft.
(.01 frargment per 100 sq. ft.)

Approx. MAE (sq. ft./bomb)
Assuming Optimum Fuzing

Short span assembly bldgs. w/o cranes	4,100
Long span assembly bldgs. w/o cranes	2,500
Multi-story earthquake resistant bldgs.	2,400
Heavy industrial bldgs. w/cranes	1,400

CRATERING: Depth (feet) x Diameter (feet) (10,000 foot altitude).

Fuzing	0.1 Sec.	0.025 Sec.	0.01 Sec.	Instantaneous
Clay	10x35	10x37	10x34	3x 7
Hard Chalk or Coral	8x27	8x27	8x26	2x 4
Sand	9x28	8x26	8x28	2x10

MINING: Distance from bomb explosion for damage to pipe: Ceramic, 40 feet; cast iron, 23 feet.
Thickness of reinforced concrete wall breached by 2 feet near miss: 6.2 feet.

PERFORMANCE AGAINST CONCRETE: (5,000 psi)
Perforation—1' maximum if dropped above 5,000 feet.
Deformation of bomb against massive concrete—800 feet.
Rupture of bomb against massive concrete—7,000 feet.

PENETRATION OF CLASS "B" ARMOR PLATE: 1.3" at approximately 500 ft./sec.

SKIP BOMBING ON WATER: Air Speed—260 knots.

Height of Release	Altitude	RICOCHET Range	Time
50'	116'	1480'	5.38 sec.
100'	127'	1100'	5.64 sec.
150'	105'	750'	5.34 sec.

Height of Release	Altitude	RICOCHET Range	Time
200'	87'	550'	4.66 sec.
250'	60'	550'	3.57 sec.

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 600 ft. (1% Theoretical Fragmmentation Risk)
Training—2,000 ft. (0.3% Theoretical Fragmmentation Risk which after extensive Army tests proved justified).
3,500 ft. (Theoretical Fragmentation Risk negligible).

BOMB: GENERAL PURPOSE, 1,000-Lb., AN-M65A1

Overall Length	69.5"
Body Diameter	18.8"
Fin Width	25.4"
Total Weight	990.0 lbs.
Explosive Weight (TNT)	558.0 lbs.

PLANE CAPACITIES:

F7F	2	FM-2	0	TBM-5	2	PBJ-1J	3	PBM-5	8
F6F	2	F4U-4	2	SB2C-5	1	PV-2	4	PB4Y-2	8

FUZING DELAYS:

144, 72, 48, 36, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.25, 0.1, 0.025, 0.01 seconds; non-delay; instantaneous; 20-80 foot air burst; hydrostatic (25'-125').

BLAST: 430 psi at 18 feet.

Radius—50% probability of casualty (instantaneous fuzing):
Man in foxhole 18', lying on ground 60', man standing 100'.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT:
(Ballistic Coefficient 3.4)

Altitude	Horizontal Bombing				40 Deg. Dive				60 Deg. Dive				90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		200 knots		400 knots		200 knots	400 knots
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	420	37	700	20	416	51	710	44	414	66	712	62	716	714
1,500	450	43	710	27	449	55	726	47	447	69	730	63	449	732
2,000	470	47	725	29	483	58	742	48	481	70	748	64	483	750
2,500	500	50	735	31	511	62	758	49	509	72	764	65	511	766
3,000	525	53	750	32	540	63	774	50	538	73	780	65	540	783
5,000	620	60	800	42	634	68	833	55	635	75	839	68	637	843
7,000	705	65	845	47	715	71	886	58	716	78	894	70	719	898
9,000	770	67	895	52	784	73	936	61	786	79	945	71	788	949
15,000	930	73	1000	58										
20,000	1020	75	1050	63										
30,000	1105	78	1100	68										
35,000	1115	79	1115	70										

Approx. MAE (sq. ft./bomb)
Assuming Optimum Fuzing

Short span assembly bldgs. w/o cranes	8,000
Long span assembly bldgs. w/o cranes	7,000
Multi-story earthquake resistant bldgs.	6,400
Heavy industrial bldgs. w/ cranes	3,900

CRATERING: Depth (feet) x Diameter (feet) (10,000 foot altitude).

Fuzing	0.1 Sec.	0.025 Sec.	0.01 Sec.	Instantaneous
Clay	14x44	13x46	18x42	4x9
Hard Chalk or Coral	10x34	10x34	10x31	2x6
Sand	11x35	10x35	11x35	3x11

MINING: Distance from bomb explosion for damage to pipe: Ceramic, 47 feet; cast iron, 29 feet.
Thickness of reinforced concrete wall breached by 2 foot near miss: 7.8 feet.

PERFORMANCE AGAINST CONCRETE: (5,000 psi)

Perforation—1 1/2' maximum if dropped above 5,000 feet.
Deformation of Bomb against massive concrete—800 feet.
Rupture of bomb against massive concrete——7,000 feet.

PENETRATION OF CLASS "B" ARMOR PLATE: 1.6" maximum at approximately 510 ft./sec.

SKIP BOMBING ON WATER: Air Speed—260 knots.

Height of Release	RICOCHET Altitude	RICOCHET Range	RICOCHET Time	Height of Release	RICOCHET Altitude	RICOCHET Range	RICOCHET Time
50'	92'	1070'	4.77 sec.	200'	28'	250'	2.52 sec.
100'	70'	690'	4.18 sec.	250'	12'	130'	1.72 sec.
150'	44'	420'	3.31 sec.				

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).

Combat — 700 ft. (1% Theoretical Fragmentation Risk).
Training—2,500 ft. (0.3% Theorertical Fragmentation Risk which after extensive Army tests proved justified).
4,500 ft. (Theoretical Fragmentation Risk negligible).

BOMB: GENERAL PURPOSE, 2,000-Lb., AN-M66A1

Overall Length	92.83"
Body Diameter	23.29"
Fin Width	31.6"
Total Weight	2106.0 lbs.
Explosive Weight (TNT)	1117.0 lbs.

PLANE CAPACITIES:

F6F	1	F4U-4	1	TBM-5	1	PBJ-1J	1	PBM-5	0
F7F	1	FM-2	0	SB2C-5	1	PV-2	1	PB4Y-2	4

FUZING DELAYS:

144, 72 48, 36, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.24, 0.1, 0.025, 0.01 seconds; non-delay; instantaneous; 20-80 foot air burst; hydrostatic (25'-125').

BLAST: 430 psi at 22 feet.

Radius—50% probability of casualty (instantaneous fuzing):
Man in foxhole 22', man lying on ground 60'+, man standing 100'+.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT:
Ballistic Coefficient—3.7)

Altitude	Horizontal Bombing				40 Deg. Dive				60 Deg. Dive				90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		200 knots		400 knots		200 knots 400 knots	
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	420	37	690	20	414	51	711	44	415	66	713	62	417	715
1,500	450	43	700	27	448	55	727	47	448	49	731	63	451	733
2,000	475	47	715	29	483	58	744	48	482	70	749	64	485	751
2,500	500	50	725	31	512	62	760	49	510	72	765	65	513	767
3,000	530	53	745	32	541	63	776	50	539	73	782	65	541	784
5,000	635	60	800	42	634	68	833	55	635	75	839	68	637	843
7,000	715	64	850	47	715	51	886	58	716	78	894	70	719	898
9,000	785	67	905	51	784	73	936	61	786	79	945	71	788	949
15,000	935	72	1005	59										
20,000	1025	75	1055	63										
30,000	1110	78	1115	69										
35,000	1130	79	1130	72										

Approx. MAE (sq./ft. bomb)
Assuming Optimum Fuzing

Short span assembly bldgs. w/o cranes	15,000
Long span assembly bldgs. w/o cranes	15,000
Multi-story earthquake resistant bldgs.	16,000
Heavy industrial bldgs. w/ cranes	10,200

CRATERING: Depth (feet) x Diameter (feet) (10,000 foot altitude).

Fusing	0.1 Sec.	0.025 Sec.	0.01 Sec.	Instantaneous
Clay	17x56	17x57	15x50	4x11
Hard Chalk or Coral	12x41	12x43	11x38	3x 6
Sand	14x44	14x44	13x43	4x15

MINING: Distance from bomb explosion for damage to pipe: Ceramic, 57 feet; cast iron, 35 feet.
Thickness of reinforced concrete wall breached by 2 foot near miss: 10 feet.

PERFORMANCE AGAINST CONCRETE: (5000 psi)
Perforation—3' maximum if dropped above 5,000 feet.
Deformation of bomb against massive concrete—1,500 feet.
Rupture of bomb against massive concrete—10,000 feet.

PENETRATION OF CLASS "B" ARMOR PLATE: 1.9" maximum at approximately 400 ft./sec.

SKIP BOMBING ON WATER: Air Speed—260 knots.

Height of Release	RICOCHET Altitude	RICOCHET Range	RICOCHET Time
50'	79'	850'	4.45 sec.
100'	43'	440'	3.25 sec.
150'	14'	180'	1.50 sec.

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 900 ft. (1% Theoretical Fragmentation Risk).
Training—3,000 ft. (0.3% Theorertical Fragmentation Risk which after extensive Army tests proved justified).
5,000 ft. (Theoretical Fragmentation Risk negligible).

BOMB: LIGHT CASE, 4,000-Lb., AN-M56A1

Overall Length	117.25"
Body Diameter	34.25"
Fin Width	47.625"
Total Weight	4205.0 lbs.
Explosive Weight (TNT)	3362.0 lbs.

PLANE CAPACITIES:
Bomb too large for Navy Type planes.

FUZING DELAYS:

Non-delay; instantaneous; 20-80 foot air burst. (Case may break-up if fused other than instantaneous or air burst.)

BLAST: 430 psi at 32 feet.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT:
(Ballistic Coefficient—2.4)

Altitude	Horizontal Bombing 300 knots	
	Vel.	Angle
15,000	900	73

Approx. MAE (sq. ft./bomb) bomb)
Assuming Optimum Fuzing:

Short span assembly bldgs. w/o cranes	48,000
Long span assembly bldgs. w/o cranes	48,000
Dense jungle area, complete clearing of	59,300

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat —1,200 ft. (1% Theoretical Fragmentation Risk).
Training—4,000 ft. (0.3% Theoretical Fragmentation Risk which after extensive Army tests proved justified).
6,000 ft. (Theoretical Fragmentation Risk negligible).

BOMB: SEMI-ARMOR PIERCING, 500-LB., A-M58A2

Overall Length	57.68"
Body Diameter	11.83"
Fin Width	16.18"
Total Weight	494.0 lbs.
Explosive Weight (TNT)	162.0 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	2	TBM-5	4	PBJ-1J	6	PBM-5	8
F7F	2	FM-2	0	SB2C-5	2	PV-2	6	PB4Y-2	12.

FUZING DELAY:
144, 72, 48, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.24, 0.1, 0.025, 0.01 seconds; non-delay.

BLAST: 430 psi at 11 feet.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT.
(Ballistic Coefficient—3.09)

Altitude	Horizontal Bombing				60 Deg. Dive				60 Deg. Dive		90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		400 knots		200 knots	400 knots
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	410	37	670	20	413	51	708	44	711	62	416	714
1,500	450	43	680	27	445	55	724	47	728	63	448	731
2,000	470	47	700	29	478	58	740	48	746	64	481	748
2,500	500	50	710	31	506	62						
3,000	525	53	725	32	535	63						
5,000	615	61	775	42	631	68						
7,000	695	65	845	46	711	71						
9,000	760	68	870	53	780	73						
15,000	920	73	965	60								
20,000	990	76	1020	65								
30,000	1065	78	1065	71								
35,000	1080	80	1080	73								

CRATERING: Depth (feet) x Diameter (feet) 10,000 foot altitude).

Fuzing	0.1 Sec.	0.025 Sec.	0.01 Sec.	Instantaneous
Clay	5x24	4x20	8x27	2x3
Hard Chalk or Coral	5x20	3x16	6x21	1x2
Sand	4x15	2x 7	7x21	1x5

MINING: Distance from bomb explosion for damage to pipe: Ceramic, 31 feet; cast iron, 17 feet.
Thickness of reinforced concrete wall breached by 2 foot near miss: 4.8 feet.

PERFORMANCE AGAINST CONCRETE:
Approximate thickness of concrete perforated (feet).

Striking Velocity (ft./sec.) / Striking Angle (degrees from horizontal)	800 / 90	800 / 60	1000 / 70	1000 / 70
3400 psi concrete	2½'	3½'	4½'	4½'
5000 psi concrete	2'	3'	3½'	3½'

Deformation of bomb against massive concrete—5,000 feet.
Rupture of bomb against massive concrete—None.

PENETRATION OF CLASS "B" ARMOR PLATE: 3.2" maximum at approximately 800 ft./sec.

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 600 ft. (1% Theoretical Fragmentation Risk).
Training—2,000 ft. (0.3% Theoretical Fragmentation Risk which after extensive Army tests proved justified).
3,500 ft. (Theoretical Fragmentation Risk negligible).

BOMB: SEMI-ARMOR PIERCING, 1,000-LB., AN-M59A1

Overall Length	70.875"
Body Diameter	15.125"
Fin Width	20.7"
Total Weight	995.0 lbs.
Explosive Weight (TNT)	220.0 lbs.

PLANE CAPACITIES:

F6F	1	F4U-4	2	TBM-5	2	PBJ-1J	3	PBM-5	3
F7F	1	FM-2	0	SB2C-5	2 (1 bomb if ammunition modified)	PV-2	4	PB4Y-2	3

FUZING DELAYS:
144, 72, 48, 36, 12, 6, 2, 1 hours; 10 minutes; 8-15, 4-5, 0.24, 0.1, 0.025, 0.01 seconds; non-delay.

BLAST: 430 psi at 15 feet.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT:
(Ballistic Coefficient—4.4)

Altitude	Horizontal Bombing				60 Deg. Dive				60 Deg. Dive				90 Deg. Dive	
	200 knots		400 knots		200 knots		400 knots		200 knots		400 knots		200 knots 400 knots	
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	420	37	700	20	416	51	712	44	416	66	714	62	417	716
1,500	450	43	720	27	449	55	729	47	450	69	732	63	451	734
2,000	480	47	735	29	483	58	747	48	484	70	751	64	485	753
2,500	510	50	745	31	511	62	764	49	513	72	768	65	514	770
3,000	540	53	755	32	540	63	781	50	542	73	786	65	543	788
5,000	635	60	820	42	640	68	844	55	641	75	849	68	642	852
7,000	715	64	870	47	723	71	901	58	724	78	907	70	726	910
9,000	790	67	920	51	796	73	954	61	797	79	962	71	798	964
15,000	955	73	1025	60										
20,000	1050	75	1080	63										
30,000	1145	79	1150	70										
35,000	1165	80	1170	72										

CRATERING: Depth (feet) x Diameter (feet).

Fuzing	0.1 Sec.	0.025 Sec.	0.01 Sec.	Instantaneous
Clay	7x32	7x32	10x32	2x5
Hard Chalk or Coral	6x23	6x23	7x23	1x2
Sand	4x17	4x17	8x27	2x6

MINING: Distance from bomb explosion for damage to pipe: Ceramic, 41 feet; cast iron, 25 feet.
Thickness of reinforced concrete wall breached by 2 foot near miss: 6.2 feet.

PERFORMANCE AGAINST CONCRETE:
Approximate thickness of concrete perforated (feet).

Striking Velocity (ft./sec.) / Striking Angle (degrees from horizontal)	635 / 50	820 / 60	1080 / 70	1130 / 70
3400 psi concrete	3′	4½′	6½′	7′
5000 psi concrete	2½′	4′	5′	5½′

Deformation of bomb against massive concrete—8,000 feet.
Rupture of bomb against massive concrete—None.

PENETRATION OF CLASS "B" ARMOR PLATE: 3.7" maximum at approximately 760 ft./sec.

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 700 ft. (1% Theoretical Fragmentation Risk).
Training—2,500 ft. (0.3% Theoretical Fragmentation Risk which after extensive Army tests proved justified).
4,500 ft. (Theoretical Fragmentation Risk negligible).

BOMB: ARMOR PIERCING, 1,000-LB., AN-MK 33

Overall length	73.0"
Body Diameter	12.0"
Fin Width	16.0"
Total Weight	1025.0 lbs.
Explosive Weight (Exp. D)	140.0 lbs.

PLANE CAPACITIES:

F6F	1	F4U-4	2	TBM-5	2	PBJ-1J	3	PBM-5	8
F7F	1	FM-2	0	SB2C-5	2	PV-2	4	PB4Y-2	8

FUZING DELAY:
.08 seconds.

BLAST: 430 psi at 11 feet.

VELOCITIES (ft./sec.) and ANGLES (degrees from) OF IMPACT.
(Ballistic Coefficient—5.3)

Altitude	200 knots		400 knots		40 Deg. Dive: 200 knots		40 Deg. Dive: 400 knots		60 Deg. Dive: 200 knots		60 Deg. Dive: 400 knots		90 Deg. Dive: 200 knots	90 Deg. Dive: 400 knots
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	410	36	695	22	417	51	714	44	417	66	716	62	418	717
1,500	450	45	705	27	450	57	732	47	451	69	735	63	452	736
2,000	480	48	720	29	484	58	750	48	485	70	754	64	486	755
2500	505	51	745	31	463	61	767	49	514	72	771	65	515	773
3,000	540	53	760	32	443	62	785	50	544	73	789	65	545	791
5,000	635	60	820	42	643	67	850	55	644	76	854	68	645	857
7,000	720	64	880	47	728	70	910	58	729	77	915	70	730	917
9,000	795	67	925	50	801	72	965	61	803	79	971	71	804	973
15,000	965	73	1045	58										
20,000	1060	75	1115	63										
30,000	1170	78	1185	68										
35,000	1195	79	1200	70										

CRATERING: Depth (feet) x Diameter (feet).

Fuzing: 0.08 sec.	
Clay	7x24
Hard Calk or Coral	5x18
Sand	6x20

PERFORMANCE AGAINST CONCRETE AND STEEL:
Approximate maximum thickness of concrete and steel penetrated.

Striking Velocity (ft./sec.) / Striking Angle (degrees from horizontal)	540 / 58	825 / 66	1060 / 72	1150 / 77
3400 psi concrete	3½'	5'	7½'	8½'
5000 psi concrete	3'	4½'	6½'	7'
Class "B" Armor Plate	3.9"	5.5"	7.6"	

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 700 ft. (1% Theoretical Fragmentation Risk).

BOMB: ARMOR PIERCING, 1600-LB., AN-MK-1

Overall Length:	83.5"
Body Diameter	14.0"
Fin Width	20.6"
Total Weight	1590.0 lbs.
Explosive Weight (Exp. D)	215.0 lbs.

PLANE CAPACITIES:

F6F	1	F4U-4	1	TBM-5	1	PBJ-1J	2	PBM-5	8
F7F	1	FM-2	0	SB2C-5	1	PV-2	2	PB4Y-2	8

Altitude	Horizontal Bombing				60 Deg. Dive				80 Deg. Dive				90 Deg. Dive	
	300 knots		400 knots		300 knots		400 knots		300 knots		400 knots		300 knots	400 knots
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Vel.
1,000	415	36	695	22	417	51	715	44	418	66	717	62	419	718
1,500	450	45	705	27	452	57	733	47	452	69	736	63	453	737
2,000	485	48	725	29	487	58	752	48	487	70	755	64	487	757
2,500	515	51	745	31	515	61	770	49	515	72	773	65	516	775
3,000	540	53	765	34	544	62	788	50	543	73	791	65	546	793
5,000	640	60	820	41	645	67	855	55	646	76	858	68	647	861
7,000	730	64	885	46	731	70	916	58	732	77	920	70	734	922
9,000	800	67	935	50	806	72	972	61	807	79	977	71	808	980
15,000	975	72	1060	58										
20,000	1080	74	1130	62										
30,000	1205	77	1230	67										
35,000	1250	79	1270	68										

CRATERING: Depth (feet) x Diameter (feet).

Fuzing	0.05 sec.
Clay	8x29
Hard Chalk or Coral	6x22
Sand	7x22

PERFORMANCE AGAINST CONCRETE AND STEEL:

Striking Velocity (ft./sec.) / Striking Angle (degrees from horizontal)	600 / 50	800 / 66	1000 / 71	1210 / 77
3400 psi concrete	4½'	6½'	9½'	11½'
5000 psi concrete	4'	5½'	8'	9½'
Class "B" Armor Plate	4.4"	6.2"	8.6"	

Deformation of bomb against massive concrete—None.
Rupture of bomb against massive concrete—None.

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 700 ft. (1% Theoretical Fragmentation Risk).

BOMB: DEPTH BOMB, 350-LB., AN-MK 54 Mod 1

Overall Length	54.6"
Body Diameter	13.5"
Fin Width	13.9"
Total Weight	354.0 lbs.
Explosive Weight (HBX)	250.0 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	2	TBM-5	4	PBJ-1J	6	PBM-5	8
F7F	2	FM-2	0	SB2C-5	4	PV-2	8	PB4Y-2	12

FUZING DELAYS:
Instantaneous; Hydrostatic (25'-125').

BLAST: 430 psi at 13 feet.

VELOCITIES (ft./sec.) and ANGLES (degrees from horizontal) OF IMPACT:
(Ballistic Coefficient—0.72)

Altitude	Horizontal Bombing				10 Deg. Dive				15 Deg. Dive				20 Deg. Dive			
	150 knots		250 knots		150 knots		250 knots		150 knots		250 knots		150 knots		250 knots	
	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle	Vel.	Angle
100	264	18	429	11	264	23	429	17	264	25	429	20	264	27	429	23
200	275	25	430	15	275	28	436	20	275	30	436	22	275	32	436	24
300	285	29	442	18	285	31	442	23	285	33	442	25	285	35	442	27
400	295	33	450	21	295	35	450	24	296	36	450	26	296	38	450	29
500	308	36	457	23	308	38	457	26	305	39	457	28	308	40	457	30

MINING: Underwater Damage to Submarines:

6,100 psi peak pressure at 22 feet—fatal.
3,000 psi peak pressure at 42 feet—heavy damage.
1,600 psi peak pressure at 72 feet—slight damage.

MINIMUM SAFE RELEASE ALTITUDES: (Horizontal flight after release)

(Instantaneous Fuzing)
Combat — 500 ft. (1% Theoretical Fragmentation Risk).
(Hydrostatic Fuzing)
80 feet.

BOMB: INCENDIARY, 4-LB., AN-M50 and Mods.

Length	21.3"
Width Across Flats	1.69"
Total Weight	3.7 lbs.
Filling Weight (Thermate)	.63 lbs.
Case Weight (Magnesium Alloy)	1.25 lbs.

FUZING DELAY:

Burning starts immediately.
In 60-70 seconds or 2-10 minutes explosion occurs in case of explosive models.

BURNING CHARACTERISTICS:

	Thermate	Magnesium Alloy Case
Time	1 1/2-2 min.	5-7 min.
Temperature	4300 deg. F.	2400 deg. F.

Description: Intensive: Filling stays near bomb. Explosive models produce about 250 fragments which will result in certain casualty within 50 feet; danger exists within 400 yards.

TERMINAL VELOCITY:

420 ft./sec.

PERFORATION PERFORMANCE:

Will penetrate light to medium-heavy roof construction; wood, tile, slate, 4 inches of reinforced concrete.

CLUSTERS: QUICK OPENING (Release from 8000 feet down to 4000 feet).

100-Lb. AN-M6 — 34 bombs (7 explosives)

Length	42.78"
Diameter	8.0"
Weight	145.0 lbs.

Plane Capacities:

TBM-5	12	SB2C-5	2	F4U-4	2	F6F	2

500-Lb. AN-M7 — 128 bombs (26 explosives)

Length	42.78"
Diameter	13.7"
Weight	540.0 lbs.

Plane Capacities:

TBM-5	4	SB2C-5	1	F4U4	2	F6F	2

PATTERN DIMENSIONS FOR AN-M50 INCENDIARY BOMBS IN QUICK OPENING CLUSTERS:

Type Cluster	Altitude of Release	Indicated Air Speed	Glide Bombing Angle	Average Pattern Area
AN-M6				
AN-M6				
AN-M7	2,300 ft.	325 knots	40 deg.	200x350 ft.
AN-M7	2,000 ft.	347 knots	65 deg.	200x350 ft.

AIMABLE (Release medium to high with cluster set to open at 5,000 feet.*)

500-Lb. M17A1 — 110 bombs (22 explosives)
(Cluster Fuze—M138)

Length	59.25"
Diameter	14.375"
Weight	460.0 lbs. (Approx.)

STRIKING VELOCITIES:

Unopened cluster from 25,000 feet—900 ft./sec. (approximately).
Individual Bombs—450 to 500 ft./sec.*
(From 25,000 feet opening at 5,000 feet.)
(*Bombs may break up—8,000 feet opening to be recommended.)
Individual Pattern (25,000 feet opening at 5,000 feet) 120x150 yards.

COMMENTS:

Generally used against targets where:

1. Vulnerability to fire is high;
2. There is a large number of small fire divisions;
3. Other incendiaries are ruled out by factors of penetration, or low plane loading efficiency.

Length .....
Width Across Flats .....
Total Weigh .....
Filler Weight (Gas Gel)

FUZING DELAY:

3-5 seconds after impact.

BURNING CHARACTERISTICS:

Time—4-7 minutes.
Temperature—1800 degrees F.
Description—Tail ejection: Burning stock of mixture is ejected up to 75 yards. New models include: M69X containing explosive charge, M69WP containing white phosphorous.

TERMINAL VELOCITY:

225 ft./sec.

PERFORATION PERFORMANCE:

Will penetrate light to medium roof construction: 1-inch wood sheathing covered with 2 layers asphalt felt; terra cotta tile, slate, 2 to 5-inch cinder concrete, 3-inch light concrete (not reinforced)

CLUSTERS:

QUICK OPENING: (Release from 2000 to 8000 feet).

100-Lb. AN-M12 ..... 14 bombs

Length ..... 39.35"
Diameter ..... 8.6"
Weight ..... 106.0 lbs.

Plane Capacities:

TBM-5 ..... 12 SB2C-5 .....2 F4U-4..... 2 F6F..... 2

500-Lb. AN-M13 .... 60 bombs

STRIKING VELOCITIES:

Unopened cluster from 25,000 feet—900 ft./sec. (approximately).
Individual Bombs—200-225 ft./sec.
(Cluster dropped from 25,000 feet opening at 5000 feet.)

Individual Cluster Pattern: (Cluster opening at 5,000 feet)—120x150 yards.

COMMENTS:

Has low striking velocity. Only suitable for attack on lightly constructed roofs.

Targets: 1. Urban Areas; 2. Any buildings with light roof construction typical of Japanese industrial practice.

BOMB: INCENDIARY, 100-LB., AN-M47A2

Overall Length	48.9"
Body Diameter	8.18"
Fin Width	10.9"
Total Weight	70.0 lbs.
Filling Weight (Gas Gel)	40.0 lbs.

PLANE CAPACITIES:
TBM-5 ..... 8 SB2C-5 ..... 2 F4U-4 ..... 2 F6F 2

FUZING:
Instantaneous, Nose.

BURNING CHARACTERISTICS:
Time—10 minutes (approximately).
Temperature—1800 degrees F.
Description—Burning fuel scattered over a radius of 50 feet. On soft ground the fuel is confined to the crater. Near-miss ineffective.

TERMINAL VELOCITY:
825 ft./sec.

STRIKING VELOCITY:
760 ft./sec. (approximately) from 25,000 feet.

PERFORATION PERFORMANCE:
5.0" re inforced concrete from 25,000 feet.

ALTITUDES:
Minimum safe release—200 feet.
Penetration good from 15,000 feet or higher.

COMMENTS:
Bomb will start appliance type fire with direct hit in large fire division.
Not recommended for Navy use because of low plane loading efficiency.

BOMB: INCENDIARY, 500-LB., AN-M76.

Overall Length	59.16"
Body Diameter	14.18"
Fin Width	18.9"
Total Weight	475.0 lbs.
Filling Weight (PT-1)	180.0 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	3	TBM-5	4	PBJ-1J	6	PBM-5	8
F7F	2	FM-2	0	SB2C-5	2	PV-2	6	PB4Y-2	12

FUZING:
Instantaneous, nose; non-delay, tail.

BURNING CHARACTERISTICS:
Time—20 minutes (approximately).
Temperature—
Description—Scatters over a 150-foot radius, but near miss ineffective because of inherent delay of 0.025 seconds.

TERMINAL VELOCITY:
1,000 ft./second.

PERFORATION PERFORMANCE:
15" concrete from 25,000 feet.

ALTITUDES:
Minimum safe release—300 feet.
Penetration good from 15,000 feet or higher.

COMMENTS:
Effective against large fire divisions or when extreme penetration is required. A very good choice for Navy Carrier-Based attack where the objective is a specific installation and not an area target. Bomb has very good ballistics for dive bombing and good stowage characteristics for carrier loading.

BOMB: Universal Droppable Gasoline Tank—150 gallons with stabilizer.
(NAPALM FILLED FIRE BOMB)

PLANE CAPACITIES:
F3A-1, F4U-11, F6F—Wing.
F7F, F8F—Wing or Fuselage.

FUZING:
Two igniters—All ways fuze and M15 (WP or Na) Grenade.

BURNING CHARACTERISTICS:
Area coverage in an ellipse approximately 100'x300' with longitudinal axis being parallel to the line of flight.

COMMENTS:
A most effective bomb for low altiude attacks against large fire divisions.

BOMB: FRAGMENTATION, 20-LB., AN-M41A1

Overall Length	22.24"
Body Diameter	3.64"
Fin Width	5.13"
Total Weight	19.8 lbs.
Explosive Weight (TNT)	2.7 lbs.

FUZING:
Instantaneous.

ANGLES (degrees from horizontal) OF IMPACT: Typical Velocities—500 ft./sec. at 5,000 feet, 650 ft./sec. at 35,000 feet.

Altitude	Horizontal Bombing		40 Deg. Dive		60 Deg. Dive	
	175 knots Angle	350 knots Angle	175 knots Angle	350 knots Angle	175 knots Angle	350 knots Angle
1,000	45	30	57	48	69	64
1,500	53	38	62	53	72	67
2,000	58	42	66	55	74	68
2,500	61	47	68	58	75	70
3,000	64	50	71	61	77	71
5,000	71	61	75	68	80	75
7,000	76	67				
9,000	78	71				
15,000	83	78				
20,000	85	81				
30,000	87	84				
35,000	87	85				

FRAGMENTATION:
Initial fragmentation velocity—2,810 ft./sec.)

Density (sq. ft./fragment)	Pattern Areas (sq. ft.) Concussion	Mild Steel 1/8"
1 sq. ft./fragment	800	750
4 sq. ft./fragment	2,800	2,400
10 sq. ft./fragment	6,400	4,650
Max. Frag. Distance	500 ft.	150 ft.

(0.01 fragment per 100 sq. ft.)

CLUSTERS:

100-Lb. Quick Opening, AN-M1A2 .... 6 bombs

Overall Length	46.6"
Overall Width	8.8"
Total Weight	125.0 lbs. (approx.)

Plane Capacities:

F6F	2	TBM-5	12	PB4Y-2	20
F4U-4	2	SB2C-5	2	PV-2	6

(Multiple suspension possible)

500-Lb. Quick Opening, M26 ..... 20 bombs

Overall Length	53 9/16"
Overall Width	14 11/16"
Overall Height	13 3/4"
Total Weight	420.0 lbs. (approx.)

Plane Capacities:

F6F	2	TBM-5	4	PB4Y-2	12
F4U-4	2	SB2C-5	2	PV-2	6

CLUSTER DISPERSION:
On the average, one-half of the bombs in each cluster will fall within a circle of 5 mil radius, and one-half will strike at a distance greater than 5 mils from the theoretical point of impact. The width of an effective pattern can more or less be based upon a total of 13 mils from one side to the other. From 21,000 feet (the only altitude listed in existing Army reports) the optimum inter-velometer spacing for 100-pound clusters is from 175 to 200 feet.

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).
Combat — 500 ft.*(1% Theoretical Fragmentation Risk).
*Release should be 800 feet or above because of bomb's angle of impact.

BOMB: FRAGMENTATION (PARACHUTE), 23-LB., AN-M40A1

Overall Length	30.15"
Body Diameter	3.64"
Parachute Diameter	4.35"
Total Weight	24.7 lbs.
Explosive Weight (TNT)	2.7 lbs.

FUZING:
Instantaneous.

ANGLE OF IMPACT:
90 degrees.

FRAGMENTATION:
(Initial Fragmentation Velocity—2810 ft./sec.)

Density (sq. ft./fragment)	Pattern Areas (sq. ft.) Concrete	Mild Steel 1/4"
1 sq. ft./fragment	1,400	1,300
4 sq. ft./fragment	5,370	4,320
10 sq. ft./fragment	11,600	8,220
Max. Frag. Distance	700 ft. (est.)	700 ft. (est.)

(0.01 fragment per 100 sq./ft.)

CLUSTER:
100-Lb. Quick Opening, AN-M4A1 .... 3 bombs
Plane Capacities:
(Not "Carrier Safe")

Overall Length	31.0"
Overall Width	10.5"
Total Weight	87.2 lbs.

BOMB: FRAGMENTATION, 90-LB., AN-M82

Overall Length	28.0"
Body Diameter	6.0"
Fin Width	8.11"
Total Weight	86.6 lbs.
Explosive Weight (Comp. B)	12.3 lbs.

FUZING:
Instantaneous.

ANGLES (degrees from horizontal) OF IMPACT:
Typical Velocities—600 ft./sec. at 5,000 feet, 870ft./sec. at 35,000 feet.

Altitude	Horizontal Bombing 200 knots Angle	Horizontal Bombing 400 knots Angle	45 Deg. Dive 200 knots Angle	45 Deg. Dive 400 knots Angle	60 Deg. Dive 200 knots Angle	60 Deg. Dive 400 knots Angle
1,000	37	18	52	44	66	62
1,500	43	23	56	46	68	63
2,000	47	29	58	47	70	64
2,500	50	31	61	48	71	65
3,000	57	40	66	54	74	68
5,000	65	49	71	60	77	71
7,000	69	55				
9,000	72	60				
15,000	77	68				
20,000	80	72				
30,000	83	77				
35,000	84	78				

FRAGMENTATION: (Initial fragmentation velocity—3,100 ft./sec.).

Density (sq. ft./fragment)	Pattern Areas (sq. ft.) Concrete	M54 Steel 1/8"	M54 Steel 1/4"
1 sq. ft./fragment	3,200	2,180	925
4 sq. ft./fragment	9,570	6,200	2,400
10 sq. ft./fragment	20,000	12,500	5,750
Max. Frag. Distance (0.01 fragments per 100 sq. ft.)	800 ft.	400 ft.	200 ft.

CLUSTER:
500-Lb. Quick or Delayed Opening, M-27..6 bombs

Overall Length	56.0"
Overall Width	15.0"
Total Weight	585.0 lbs.

Plane Capacities:
PV-2 .... 6 TBM-5 .... 4 PB4Y-2 12
(Status questionable pending further carrier tests)

NOTE:
Now available for limited use: M86, 120-Lb. Para Frag Bomb which is the parachute adaptation of the AN-M82.

Preliminary data is as follows:

Length	35.5"
Diameter	6.5"

At speeds of 220 knots or greater, 90 feet (minimum altitude for satisfactory functioning assembled with AN-M120A1 fuzes) is safe altitude for rerelease of H.E. loaded M86 bombs.

Multiple suspension of two bombs per rack is possible. This method of suspension has been successful in proving ground tests using B-25 and P-51 aircraft.

BOMB: FRAGMENTATION, 260-LB., AN-M81

Overall Length	43.6"
Body Diameter	8.0"
Fin Width	11.0"
Total Weight	263.0 lbs.
Explosive Weight (Comp. B)	86.2 lbs.

PLANE CAPACITIES:

F6F	2	F4U-4	2	TBM-5	8	PBJ-1J	8	PBM-5	8
F7F	2	FM-2	2	SB2C-5	4	PV-2	6	PB4Y-2	12

FUZING:

Instantaneous nose; non-delay tail; 20-80-foot air burst.

ANGLES (degrees from horizontal) OF IMPACT.

Typical Velocities—650 ft./sec. at 5,000 feet, 1040ft./sec. at 35,000 feet.

Altitude	Horizontal Bombing 300 knots Angle	Horizontal Bombing 400 knots Angle	40 Deg. Dive 300 knots Angle	40 Deg. Dive 400 knots Angle	60 Deg. Dive 300 knots Angle	60 Deg. Dive 400 knots Angle
1,000	37	18	52	44	66	62
1,500	43	23	56	46	68	63
2,000	47	29	58	47	70	64
2,500	50	31	61	48	71	65
3,000	54	33	63	50	72	65
5,000	62	44	69	56	75	69
7,000	66	50				
9,000	69	54				
15,000	74	62				
20,000	77	67				
30,000	80	72				
35,000	81	74				

FRAGMENTATION: (Initial fragmentation velocity—3,410 ft./sec.).

Density (sq. ft./fragment)	Pattern Areas (sq. ft.) Concentration	1/8"	20Rd Blast 1/4"	1/2"
1 sq. ft./fragment..	4,500	3,430	1,380	575
4 sq. ft./fragment..	14,120	10,800	5,870	1,530
10 sq. ft./fragment..	29,700	22,100	11,970	3,900
Max. Frag. Distance	1,000 ft.	600 ft.	400 ft.	200 ft.

(0.01 fragment per 100 sq. ft.)

MINIMUM SAFE RELEASE ALTITUDES: (Short delay fuzing; horizontal flight after release).

Combat — 650 ft. (1% Theoretical Frargmentation Risk).

Training—2,000 ft. (0.3% Theoretical Fragmentation Risk which after extensive Army tests proved justified).

3,500 ft. (Theoretical Fragmentation Risk negligible).

BOMB: FRAGMENTATION (BUTTERFLY), 4-LB., M83

Overall Length	3.0"
Overall Diameter	3.0"
Total Weight	3.2 lbs.
Explosive Weight (TNT)	0.47 lbs.

FUZING DELAYS:

Aerial or ground burst; 1-30 minutes; anti-disturbance.

FRAGMENTATION:

The only information that is available at the present time shows an average of one casualty producing fragment per three square feet of exposed area at a distance of ten feet from the point of detonation, and one casualty producing fragment per seven square feet at a distance of 20 feet from the point of detonation. Since a standing man exposes about four and one-half square feet of area, one may expect that most men standing within fourteen feet of the bomb will be killed or wounded and that approximately 60% of the men standing at 20 feet will be killed or wounded. Statements about possible damage at greater rdistances cannot be made since there is no data, but it is probable that there would be small danger of casualty producing fragments beyond 80 feet.

CLUSTERS:

100-Lb. Delay Opening, M28 ..... 24 bombs

Overall Length	47.35"
Overall Diameter	8.0"
Fin Width	10.94"
Total Weight	155.21 lbs.

Plane Capacities:

TBM-5 ..... 12 SB2C-5 2

500-Lb. Delay Opening, M29 ..... 90 bombs

Overall Length	59.365"
Overall Diameter	13.89"
Fin Width	18.94"
Total Weight	415.2 lbs.

Plane Capacities:

TBM-5 4

CLUSTER DISPERSION:

Pattern roughly 200x300 feet under the following conditions:

1. Released from 5,000 feet with fuze setting of 8 seconds.
2. Released from 3,000 feet with fuze setting of 5 seconds.
3. Released from maximum altitude of 8,000 feet with fuze setting of 16.5 seconds.

Note: Additional velocity caused by altitudes of release greater than 8,000 feet with 16.5 second fuze setting will tear butterly wings from bomb when the cluster opens.

ROCKETS

Motors of both 3.5" and 5.0" A.C. are 3.25" in dia

3.5" AIRCRAFT ROCKET (Mk 1, 2 or 3 Head on the Mk 7 Motor)

Overall Length	54.7"-56.0"
Motor Diameter	2.25"
Head Diameter	3.5"
Total Weight	53.8" lbs.
Explosive Weight *	None
Fuzing	None
Velocity Relative to Plane	960-1100 ft./sec. at end of burning.

Underwater trajectory good. Can be used against ships up to and including DD's.)

(*There is also a 3.5" FS Smoke Head, the Mk 9 and Mk 6.)

5.0" AIRCRAFT ROCKET (Mk 1 Head on the Mk 7 Motor)

Overall Length	66.0"
Motor Diameter	2.25"
Head Diameter	5.0"
Total Weight	81.4 lbs.
Explosive Weight	8.6 lbs.
Fuzing	0.02 sec. base and/or instantaneous nose.
Velocity Relative to Plane	635-800 ft./sec. at end of burning.

5.0" HIGH VELOCITY AIRCRAFT ROCKET (Mk 6 Mod 0 Head on the Mk 2 Mod 3 Motor)

Overall Length	89.0"
Motor Diameter	5.0"
Head Diameter	5.0"
Total Weight	140.0 lbs.
Explosive Weight	Approx. 9 lbs.
Fuzing	0.015 base and/or instantaneous nose.
Velocity Relative to Plane	1240-1335 ft./sec.

Accuracy (rough estimates based largely on training results).

1. Rocket attack, CEP—30 feet.*
2. Dive Bombing, CEP—200 ft.
3. Medium level bombing, CEP—600 feet.

*(CEP for rocket attack is determined by assuming that 50% will land within a circle of 20 mil radius. A 500-yard range was chosen to establish the CEP of 30 feet.)

Performance Against Fortification and Armor:

1. Maximum thickness concrete slab perforated by inert head:
   5000 psi reinforced concrete (Navy tests) 1 1/2 feet.
   4000 psi non-rerinforced concrete (Army tests), 3 feet.
2. Maximum thickness concrete slab perforated by penetration and explosive effects of H. E. head with 0.02 second base fuse:
   4500 psi reinforced concrete (Army tests) 3 feet.
   4000 psi semi-reinforced concrete (Army tests) 4 feet.
3. Thickness of concrete slab necessary for protection against ricochet hit with H. E. head (Army test) 1 foot.
4. Thickness of sand covering necessary for protection against H. E. round (Army tests) 3 feet for dives up to 20 degrees.
5. Maximum thickness of mild steel plate against which delay fuzed H. E. head can be fired without defeat of round (Navy test) 1 inch.
6. Maximum thickness STS armor plate against which delay-fuzed H. E. head can be fired without defeat of round (Navy tests) 5/8".
7. Maximum thickness STS armor plate seriously damaged by instantaneously-fuzed H. E. head (Navy tests) 1 5/8".

ROCKETS (Continued)

11.75" AIRCRAFT ROCKET (Mk. 2 Head on the Mk 1 Mod 3 Motor)

Overall Length	**119.0"**
Motor Diameter	**11.75"**
Head Diameter	**11.75"**
Total Weight	**1255.0 lbs.**
Explosive Weight	**152.5 lbs.**
Fuzing	.02 second delay base fuze
Velocity relative to plane	780 to 810 ft./sec. at end of burning.

Performance Against Fortifications and Armor:

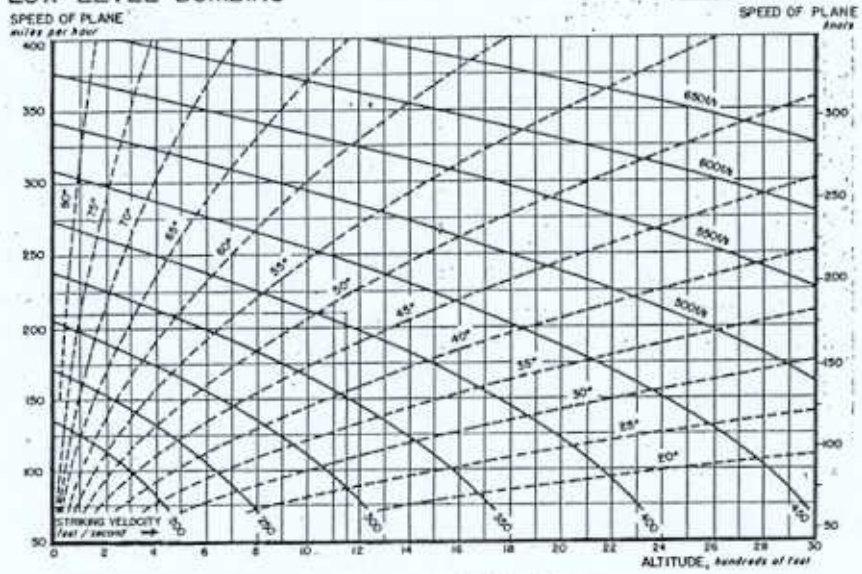
Actual combat data is lacking at this writing, and the only facts available would be those based on preliminary tests of air firing against 5000psi concrete using the Mk 2 head with three base fuzes, Mk 157 Mod 2, installed. These tests indicate that to a certain extent the performance of the Tiny Tim parallels that of the 500-Lb. SAP bomb which was modified to form the 11.75" A.R. head:

1. Maximum thickness concrete slab perforated by round with inert head:
   5000 psi reinforced concrete—4 to 5 feet depending on obliquity.
2. Maximum thickness concrete slab scabbed by inert head:
   5000 psi reinforced concrete—5 to 6 feet depending on obliquity.
3. Maximum thickness STS armor plate against which H. E. head can be firedr without defeat of round—3 to 3.5 inches.

WEAPON DATA

1 B 4
FLIGHT
LOW LEVEL

LOW LEVEL BOMBING



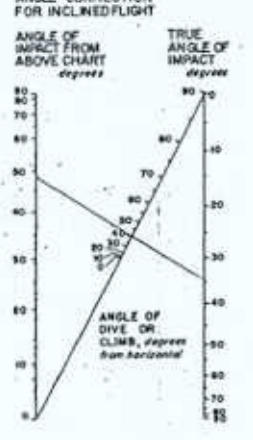
This sheet gives flight characteristics of bombs released from low altitude (up to 3,000 ft), based on the trajectory in a vacuum. True striking velocity and angle of impact will both be less than values read from chart, but at the highest plane speed and altitude on graph, the error in striking speed is 16% for the 100 lb G.P. bomb and 7% for the 1000 and 2000 G.P. Errors in impact angle are 3° or less. For data on level-flight bombing from altitudes above 3000 ft it is advisable to use sheets following, which give actual flight characteristics for individual bombs.

HORIZONTAL FLIGHT: Locate a point on the graph by projecting upward from the given altitude and across from the given plane speed. Using this juncture, interpolate between the solid-line curves to obtain striking velocity and between the broken-line curves to read angle of impact (measured from the vertical).

DIVE OR CLIMB: Magnitude of striking velocity is determined same as for horizontal flight. Impact angle is found by reading an angle from the chart as for horizontal flight and correcting it by means of the angle of dive or climb, using the nomogram.

Examples: Dotted lines on graph show that a bomb dropped from a plane flying at a speed of 210 mi/hr at an altitude of 1150 ft in either horizontal or inclined flight will strike the ground at a speed of 410 ft/sec. If this plane is flying level, the impact angle (measured from vertical) will be about 48°; if at an angle of 40° the impact angle (see dotted line on nomogram) will be about 35°.

ANGLE CORRECTION FOR INCLINED FLIGHT



FORMULAS: BOMB TRAJECTORY IN VACUUM IS BASED ON FOLLOWING RELATIONS.

$$V_s = 1.467\sqrt{V_x^2 + 29.9h} \qquad X = 1.467\, V_x\, t \cos\alpha$$

$$\sin\theta_x = \frac{V_x}{\sqrt{V_x^2 + 29.9h}} \qquad \sin\theta_g = \sin\theta_x \cos\alpha \pm \frac{V_x \cos\theta}{\sqrt{V_x^2 + 29.9h}}$$

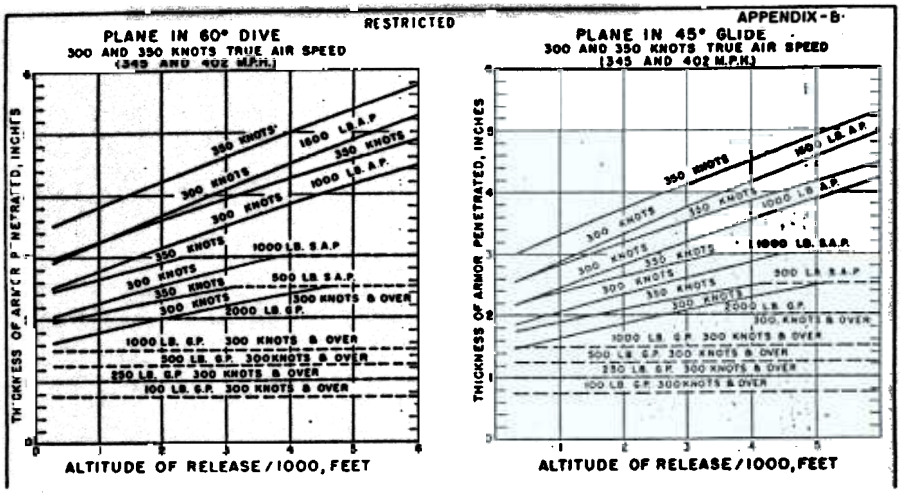
$$t = 0.0456\left[\sqrt{V_x^2 \sin^2\alpha + 29.9h} \pm V_x \sin\alpha\right] \text{ (use + sign for climb, - sign for dive)}$$

where:

V_x = airplane speed, mi./hr.
V_s = striking speed, ft./sec.
θ_x = impact angle for level flight, degrees from vertical
θ_g = impact angle for inclined flight, degrees from vertical
α = angle of dive or climb, degrees from horizontal
X = horizontal range of bomb trajectory, feet
h = altitude of bomb release, ft.
t = time of flight, sec.

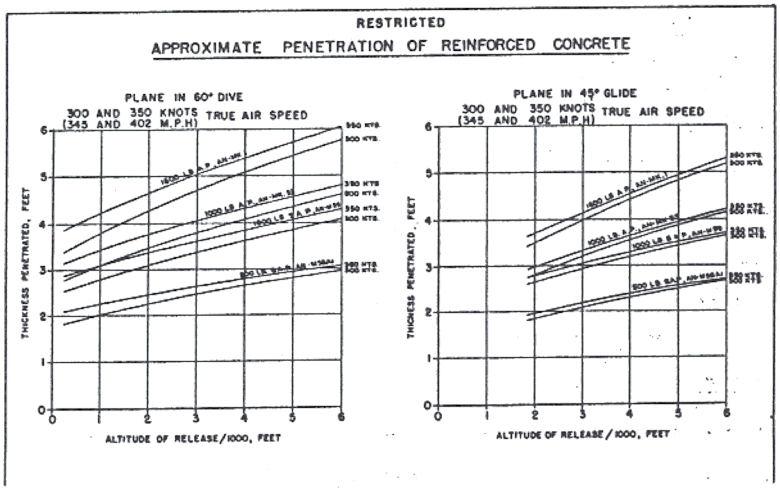
APPENDIX B

APPROXIMATE PENETRATION OF ARMOR PLATE



Source - BUORD, Navy Dept.

Accuracy - about 15%



Source - AAF Board

Accuracy - about 15%

APPENDIX C

Sources and Methods used in compiling notes.

References:

a. "Bomb Data Sheets," Joint Target Group.

b. "Weapon Data, Fire Impact and Explosion," N.D.R.C., Div. 2, Princeton University Station.

c. "Army Air Force Board Reports."

d. "Ammunition Drawings," Chief of Ordnance, U. S. Army.

e. "United States Bombs and Fuzes," USN Bomb Disposal School, 1 June 1944.

f. "Advanced Fuze and Explosive Ordnance Bulletins," Nos. 1 through 15, USN Bomb Disposal School.

g. Ordnance Pamphlet No. 878 (Second Revision) 21 Sept. 44, "General Data on Navy, AN-Standard Army and British Bombs."

h. "Terminal Ballistic Data, Vol. I, Bombing," Office of the Chief of Ordnance, War Department, August 1944.

i. Ordnance Pamphlet No. 1160, 24 May 44, "Bomb Ballistic Data."

j. Ordnance Pamphlet No. 1172, 9 May 44, "Performance of Bombs and Projectiles Against Shore Installations."

k. "Ricochet Graphs and Tables Targets on Water," Office of the Chief of Ordnance, 29 Feb. 43.

l. "Aviation Ordnance Summary," 1 Sept. 44.

m. "Bomb Load Chart," 13 July 44, BuAer-NAVAER 00-45R-1.

n. FTP-224 "Selection of Bombs and Fuzes for the Destruction of Various Targets," October 1944.

o. TM-9-1980, "Bombs for Aircraft," November 1944.

p. 7th AAF, "Ordnance Officers' Handbook."

q. Cominch ltr. FF1/A5-5/F41 Serial No. 02392 of 14 July 1944. "Minimum Altitude of Planes Following Release of Live Bombs, Including Depth Bombs."

r. AAF Board Report, 29 April 44, "Tests of Minimum Altitude for Safe Bomb Release."

s. AAF Board Report, 7 Dec. 44 "Supplementary Test on Minimum Altitude for Safe Bomb Release."

Methods used:

1. General Description: References (a), (d), (e), (f), (g), (o).
2. Plane Capacities: References (a), (l), (m), and personal observation.
3. Fuzing Delays: References (a), (d), (e), (f), (g), (o).
4. Blast: Distance for 430 psi peak pressure: Reference (b). Distances for men standing and lying down were taken from Reference (p). The derivation of these latter figures (Ref. (p)) by an ORS Group was a bit round-about and should probably be taken with certain reserve.
5. Velocities and Angles of Impact: References (i), (h), and (b).
6. Fragmentation: Polar coordinate plots in Reference (h) were measured with a planimeter.
7. Cratering: Reference (j).
8. Mining: Reference (b).
9. Performance against concrete: Reference (i).
10. Performance against steel: Reference (b).
11. Skip Bombing on Water: Reference (k).
12. Minimum Safe Altitudes of Release: Combat Altitudes: Reference (q); Training Altitudes: References (r) and (s).
13. Data on Incendiary Bombs: Reference (a).
14. Data on Rockets: Reference (c) and N.O.T.S. Inyokern tests.